Michelson, Morley and Me:
How We See, Hear, and Hear Movies

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> Does the aether really exist? One knows where our belief in the aether stems from. When light is on its way to us from a far star … it is no longer on the star and yet not yet on the earth. It is necessary that it is somewhere, sustained, so to say, by some material support.
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> Henri Poincaré (1900)[1]

> Sounds come from outside the body, but sound itself is near, intimate; it is an excitation of the organism; we feel the clash of vibrations throughout our whole body. … Generally speaking, what is *seen* stirs emotion indirectly, through interpretation and allied idea. Sound agitates directly, as a commotion of the organism itself. Hearing and sight are often classed together as the two "intellectual" senses. In reality the intellectual range of hearing though enormous is acquired; in itself the ear is the emotional sense. Its intellectual scope and depth come from connection with speech; they are a secondary and so to speak artificial achievement, due to the institution of language and conventional means of communication. Vision receives its direct extension of meaning from connection with other senses, especially with touch. The difference works both ways. What is true of hearing on the intellectual side is true of seeing on the emotional. … Apart from the emotional effect of formal relations, the plastic arts arouse emotion through *what* they express. Sounds have the power of direct emotional expression. A sound is itself threatening, whining, soothing, depressing, fierce, tender, soporific, in its own quality.
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> John Dewey (1934)[2]

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[1] As cited by Abraham Pais in his *Subtle is the Lord: The Science and the Life of Albert* Einstein (Oxford: Oxford University Press, 1982), page 127, translated by Pais from the *Report of the International Physics Congress*, C. Guillaume and L. Poincaré, editors, Vol. 1 (Paris: Gautier-Villars, 1900), page 1. Poincaré's address was subsequently reprinted in a translation by 'W.J.G.' as Chapters IX and X, pages 140–182, of Poincaré's *Science and Hypothesis*, preface by J. Larmor (New York: Walter Scott Publishing Company, 1905), with the passage quoted appearing in subtly differing wording on page 169.

[2] John Dewey, *Art as Experience* (New York: Minton, Balch & Company, 1934) pages 237 and 238)

> … music does more than intensify the impression of the visual image by providing a parallel illustration of the same idea; it opens up the possibility of a *new*, transfigured impression of the same material: something different in kind. … With the introduction of the musical progression, the life recorded in the shot can change its colour and sometimes even its essence. …Properly used, music has the capacity to change the whole emotional tone of a filmed sequence; it must be so completely one with the visual image that were it to be removed from a particular episode, the visual image would not just be weaker in its idea and its impact, it would be qualitatively different.
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> I'm not sure that in my films I have always succeeded in fulfilling the theoretical demands I am putting forward here. I have to say that in my heart of hearts I don't believe films need music at all. However, I have not yet made a film without it …
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> Andrey Tarkovsky (1986)[3]

Among the misapprehensions that have undermined filmmaking, pride of place must go to the failure of many filmmakers to acknowledge how the sounds that we hear by means of movies determine how we experience what we see by means of them.

> How astonishing it should seem to us, even today, but seldom does, that the Lumière brothers should have acknowledged over a century ago that the members of their audience at the first public presentation of films would have to hear a piano playing to engage with whatever they were seeing.
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> How astonishing that within a world wherein drawings, paintings and sculptures have for millennia riveted human beings attending to them within quiet spaces, and wherein photographs have for nearly two centuries been similarly engaging, no tradition of *silent* filmmaking has ever taken root, much less an art of 'colour music' within it.[4]

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[3] Andrey Tarkovsky, *Sculpting in Time*, translated by Kitty Hunter-Blaire (New York: Alfred A. Knopf, 1987 [1986]), pages 158 and 159. I have substituted the word 'shot' for Hunter-Blaire's 'frame', as one must do throughout the text to understand what Tarkovsky means.

[4] The only filmmaker of note, for example, who after the advent of synchronous sound produced films intended to be shown in silence, Stan Brakhage, did so without either continuing a tradition within filmmaking or starting another, well-aware of the idiosyncrasy of his endeavours. Reasonable human beings may differ in their assessment of his achievement, but its exceptionality – to the point of being a tour-de-force – is undeniable.

> How astonishing that the advent of audiovisual synchronization revolutionized filmmaking constructively and institutionally, unlike any other of the technical innovations that have refined it or any other art.
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> How astonishing, consequently, that so many filmmakers, even today, think of the sounds of their films as of supplementary rather than fundamental importance.

For filmmaking, contrary to legend, is and will remain, as it has always been, an auditory enterprise, for how we are seeing by means of a film depends upon how we *are* as we do so, and how we are – that is, how we *have become* as we view it – is in larger part determined by how we have *become the sounds* that we are hearing.

To understand how this is possible, we must attend to how differently we see and hear because light and sound waves are differently propagated, for how those waves impinge differently upon us determines how differently we register their presence, and how distinctly they affect our awareness of who (that is, how) we are.

Let me remind you, therefore, of an experiment conducted in the late nineteenth-century that was for other reasons to command the attention of physicists, for, reconsidered, it is the watershed event that ought as well to have compelled us to acknowledge how hearing differs from seeing, and hence how hearing is decisive to how we identify ourselves and thereafter identify what we see, including what we see by means of films.

The Background to the Experiment[5]

When Cambridge University closed in the fall of 1665 to avoid the plague, Isaac Newton, having graduated in August as an undistinguished twenty-three year-old student of mathematics, was compelled to return to his home at Woolsthorpe, near Grentham, England. When the university reopened eighteen months later, Newton returned having in the interim invented the 'calculus', the three laws of motion and the principal of universal gravitation and having performed the first definitive experiments into the nature of coloured light, overthrowing the unitary construal of 'white light' presumed since Aristotle. As postgraduate holidays go, it had been something of a working success.

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[5] The summary of the events that I recount in this section of the essay is derived from the most comprehensive account of them in English, namely Sir Edmund T. Whittaker's *A History*

Newton had envisaged his mechanical model of the world without having to conduct experiments. To investigate light and colour, however, he was compelled to use equipment so rudimentary that he was unable with it to produce a ray of light of sufficient coherence to enable him to observe it bending around corners (diffraction), a phenomenon that others had claimed to have witnessed. Consequently, when he tried to explain the results that he had been able to obtain, all of them explicable if light moved in straight lines, he felt obliged to insist that light must *in some way* be corpuscular in nature, propagating through space as a sequence of discrete units following one upon the other in accordance with the mechanical laws governing all other things, contrary to the prevailing Cartesian opinion that light was a wave-motion.[6]

Newton's conclusion was to be confirmed famously two-and-a-half centuries later when Alfred Einstein in 1905 explained the photoelectric effect by assuming that light, like Planck's black-body radiation of 1901, was quantized. Einstein's reaffirmation, however, was by then revolutionary, for by the late nineteenth century the evidence for the wave-like propagation of light, presumed incompatible with a corpuscular account, had accumulated to the point where it seemed to most physicists overwhelming.

As early as 1678 Christian Huygens had been able to explain the refraction of light, and almost all of the other available experimental data (polarisation excepted), by assuming

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of the Theories of Aether and Electricity, *Volume I: The Classical Theories* (London: Longman, Green, 1910). The sequel, *Volume II: The Modern Theories 1900-1926* (New York: Nelson & Sons, 1953), completed forty-years later, is far-less trustworthy though more provocative, for Whittaker, taking sides on a complex and puzzling issue of historical priority, entitles his crucial chapter on relativity "The Relativity Theory of Poincaré and Lorentz", construing Einstein has having simply tidied-up their insights. Pias considers the first volume a "masterpiece", whereas within the second the "the author's lack of physical insight matches his ignorance of the literature" [Pias, op. cit., page 168). With all respect to Pais and his remarkably cautious and fulsome work, one should keep in mind that he is writing a biography of his friend and colleague, Einstein, and that the issue is complex and puzzling; for, as he himself notes, physicists as competent as Max Born have shared Whittaker's judgment. " The reasoning used by Poincaré was just the same as that which Einstein introduced in his first paper of 1905 … Does this mean that Poincaré knew all this before Einstein? It is possible …" (Born, cited by Pais, op. cit., page 172, from an address given by Born in Bern in 1955 as a contribution to a celebration of the 50th-anniversary of special relativity, published in a supplement to *Helvetica Physica Acta*, *4* (1956), page 411).

[6] Newton was uncommonly cautious in his conclusions about how things are, here as elsewhere, and the tendency to suggest that he advocated a corpuscular *rather than* wave theory of the propagation of light is erroneous. As even a cursory reading of his letters to Oldenburg will attest, for example, he attempted unceasingly to meld the particulate with the wavelike, resulting in his attempts to identify the former with 'fits', or spurts, of the latter.

that light was propagated as a wave at very high speeds.[7] By 1803 Thomas Young had shown how, by passing a ray of light through a narrow slit, one could render it sufficiently coherent that when it was in turn split in two, and the two halves allowed in impinge upon one another after passing through two parallel slits, they would interfere with one another, as only waves could do, producing alternating bands of light and dark that all could see. When Augustin Fresnel in 1817 showed how Young's results could be accommodated mathematically as part of a general account of wave-phenomena encompassing fluids and solids as well, predicting novel effects soon confirmed, the wave theory of light became the preferred model for most physicists. And when a half-century later, in 1862, Clerk Maxwell encompassed light as one among many electromagnetic wave phenomena governed by a single unified set of field equations, giving the correct speed of propagation for it while predicting wave-like behaviour across the entire spectrum, a prediction that Gustav Hertz soon confirmed when he detected low frequency radio-waves, the wave theory of light seemed to most physicists to be not only a game that had to be played when attempting to understand it, but the only game in town.

To play that game, however, or so it seemed, one had to assume the existence, as Fresnel had suggested in a prescient letter of 1818, of a stationary but elastic substance permeating the universe by means of which electromagnetic energy, and therewith light, could be propagated, a wavable medium so odd as to defy comprehension.

Waving Things

Suppose you were to point a gun at me and pull the trigger. Were your aim good, a bullet would pass through the space from you to me, striking me with destructive force, and it would do so were we standing on the corner of Yonge and Bloor or floating weightless in the vacuum aside a spaceship moving toward Mars.

But imagine, on the contrary, that you were to clap your hands while standing across from me in a large room, and that I were to *hear* you do it. How is that possible? Because there is an elastic medium within which we are standing, the air surrounding us in the room and filling the space between us, that has been set into wave-like vibration by the striking together of your hands, the wave-front propagating from you to me as the molecules touching your hands transmit the vibration to their neighbours, and they in turn to their neighbours, until those impinging upon me (upon my ear drums primarily, but also upon the rest of my body) cause me to vibrate as they do.

[7] Huygens's results, however, were only published in 1690.

Or imagine comparably that you were to drop a large rock into a pond upon which I am canoeing. The molecules of water displaced by the rock would press wave-like against their neighbours, and their neighbours against theirs, until those impinging upon my canoe would try to displace it, and me, as they have been displaced.

In all three examples something would have passed from you to me across a space which, were it to do so with sufficient energy, would do me damage. If inattentive, one might be tempted to suppose, therefore, that waves of sound or water propagate across spaces as bullets do. But their ways of doing so differ more remarkably than can be imagined, and I speak exactly.

Were I to flop over because I have been struck by a bullet fired from a gun in your hand, the bullet would *itself* have had to have passed across the space from you to me. Were I to hear you clap your hands, however, or were I and my canoe to be upset by a sudden slap of water pushing against it because you heaved a rock into the pond, the effect would again have been caused by the movement of particulate things, molecules of air or of water, but *none* of them would have passed across the space between you and me.

Unlike the moving bullet, the vibrating molecules of air or of water propagating the waves would have been displaced only a short distance away from where they had been resting, returning almost immediately to almost the same place from which they began, having pressed only briefly against their neighbours as they pass the wave along (the molecules of air being displaced along the direction of the wave, or longitudinally, those of water at right angles to the wave, or transversely).[8] Only the temporal *form* of a medium has moved wave-like from you to me, perhaps shattering my eardrums or sinking my canoe. A local and temporary displacement of the parts of an elastic medium already reaching from you to me has transferred a wave of energy from one of its regions to another, and when the wave has passed through it, the medium, in whole and part, is as it was before, ready to be waved again and again.

As a sage might say, the medium – but only when waving – is the message.

An energized bullet crosses a space without need of a medium; an intervening medium, indeed, would impede it. Waves of sound or of water, however, being only the moving form of their vibrating media, require them. For physicists of the late nineteenth

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[8] One need only observe the motion of a cork floating atop waving water when displaced by a wave, for example, to witness the pattern of displacement, and return, of the molecules of water supporting the cork as the wave passes along the surface by means of their movement up-and-down.

century (or the ninth century, for that matter), to have spoken of a wave unidentified with *how* a medium was waving would have been to talk nonsensically – to have spoken, that is, contrary to the very conditions of how a wave could be. Or so it seemed to almost everyone circa 1880.

But if light rays are waves propagating through the waving of a medium, what kind of medium could it be? As early as 1638, Descartes had named it the 'aether'. The problem, however, was to fathom how we could come to know anything of it.

The aether had to permeate the entire universe, permitting electromagnetic energy, with light a part of it, to propagate anywhere by its waving. Since light travels through empty space, a vacuum, the aether had to be where *nothing* else was; and since light passes through various solids, liquids and gases (glass, water and air, for example), the aether had as well to be occupying the very same places where *everything* else was without in any way affecting them or their interactions.[9] But how then, affecting nothing else, could it be measured? How could we come to know anything about it?

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[9] Light fails to pass through rocks or steel, of course, but, since other forms of electromagnetic energy pass unimpeded through them and through other things as well, the hypothesis of the ubiquity of the aether was unaffected. I neglect here, and elsewhere in my account, many such niceties that provoked eminent physicists into accepting the hypothesis at the time, and occasionally to reconsider its virtues even after its general rejection. Henri Poincaré, for example, continued to his death in 1912 to believe, or seemingly so, that the principles of the (special) theory of relativity had to be supplemented in some way by aspects of the Fitzgerald-Lorentz contractions, even though he could hardly have failed to recognise that they are derivable from it, and Hendrik Lorentz himself, though unable to envisage any way around the consequences of relativity, died in 1928 believing it to be 'dynamically' inadequate, both men refusing to jettison the hope that the aethereal hypotheses might be saved. See the provocative account by Pais, op. cit., in Chapter 8, "The Edge of History", pages 163-174. As late as 1951, indeed, Paul Dirac was to suggest that a theory unifying the theories of relativity and the quantum might well require the reconsideration the hypothesis of the aether: "… We may set up a wave function which makes all values for the velocity of the aether equally probable. Such a wave function may well represent the perfect vacuum state in accordance with the principal of relativity." Cited by Adolph Grünbaum, *Philosophical Problems of Space and Time*, Second, enlarged edition, Boston Studies in the Philosophy of Science, Vol. XII (Dordrecht, Holland: D. Reidel Publishing Company), p. 725, from page 906 of an essay by Dirac entitled "Is There an Aether" published in *Nature*, volume 168, 1951.

The Michelson-Morley Experiment[10]

In August of 1881, an article appeared in the *American Journal of Science* written by Albert Michelson, a young American officer on leave from the Navy doing postgraduate work within the laboratory of Hermann Helmholtz in Berlin, Germany. Michelson, an expert in the design of experiments measuring the velocity of light (three papers already published), had conducted a remarkable investigation.[11]

If a stationary aether pervades the universe, then the earth must be passing through it as it journeys yearly around the sun, changing direction with respect to the aether through which it is drifting as the year progresses. Without affecting in any way the earth itself, those changes of direction ought to affect the velocity with which light rays appear to propagate when emitted in different directions with respect to the aether at different times of the year. As a boat travelling with a current encounters less resistance than when travelling against it, a light ray emitted upon the earth in a direction that coincides with the prevailing direction of the aether, its medium, ought to encounter less resistance than a ray emitted in a contrary direction.

Were we, then, to split a beam of light in two, sending the halves along paths of exactly the same length but at right angles to each other onto mirrors that would bounce them back, we should be able to detect the difference between them as they recombine. One of them should have taken less time to make its journey than the other, because it happened to have been emitted in a direction coinciding more exactly with the direction of the aether through which the earth was drifting. When recombining, the two rays, no longer vibrating synchronously, should then interfere with one another, and we ought to be able to see the patterns of interference and, by measuring them, determine how the earth was moving relative to the aether.

Young Michelson had constructed a machine, the first *interferometer*, capable of doing the above, and had conducted the experiment. To his surprise, however, he had been unable to detect any difference between the time taken by the two travelling rays, for they had invariably recombined synchronously without inferring with one another.

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[10] Descriptions of the experiment of Michelson and Morley and the physical calculations involved are available in standard textbooks. For an account of the historical context of their work, presented with exemplary comprehension and precision, readers may turn to Pais, op. cit., Chapter 6, pages 111-117, from which my sketch of the biographical information of Michelson and his work is drawn.

[11] A. A. Michelson, *American Journal of Science*, **22**, 120 (1881).

Soon after Michelson's work became known, Hendrik Lorentz, the Dutch physicist now renowned for later work that propelled Einstein toward the theory of relativity, uncovered a flaw in the design of the experiment that might have compromised its results. Although physicists noted and respected Michelson's results, therefore, few were prepared to accept them. So, five years later, Michelson, now working in Cleveland with the assistance of the chemist Edward Morley, constructed another interferometer with even greater care, and, avoiding the previous infelicities, re-ran the experiment. The results, negative as before, were published in 1887, and this time the design of the experiment could not be faulted.[12] Physicists were compelled to acknowledge Michelson's conclusion of five years before.

> The result of the hypothesis of a stationery aether is thus shown to be incorrect, and the necessary conclusion follows that the hypothesis is erroneous.[13]

Light waves propagate from source to destination, that is, without need of a medium waving between them.

Two decades later, in 1905, Albert Einstein, while working as a young postal clerk, published five papers that provoked the destruction of the foundations of classical physics. Among them was a brief essay in which he assimilated as one of the two postulates of the special theory of relativity that the velocity of light is constant for all observers in the universe, regardless of their motion relative to it – the cardinal consequence of the experiment of Michelson and Morley.

Seeing Contra Hearing

The experiment of Michelson and Morley was the watershed event in our coming to understand how differently waves propagate. As such, it might also have served as the watershed in our coming to understand how hearing differs from seeing, and hence how differently we encounter things by means of a film when heard rather than seen.

The experiment of Michelson and Morley, in a nutshell, distinguished waves like light that propagate without anything waving from those like sound that propagate only through waving media. But then,

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[12] A. A. Michelson and E. W. Morley, *American Journal of Science*, **34**, 333 (1887)
[13] From Michelson (1881), as quoted by Pais (1982), page 112.

> Seeing is a mode of perceiving that differs radically from hearing, for we see without any medium having touched us, whereas we hear only by *conforming ourselves* to a medium touching us.

When we are seeing, we are registering how the electromagnetic energy that is falling upon the rods and cones of our retinas is waving. We do so, however, without our retinas becoming in any way like any medium waving against them, for, as the experiment of Michelson and Morley showed, no such medium exists. Our eyes register the wave-like light falling upon them, that is, without in any way becoming wave-like (without embodying, that is, how any waving medium is touching them), for light rays, although wave-like, propagate without any medium being waved.

Each of our rods and cones responds to a broad range of the frequencies impinging upon it, firing without regard to any differences between those frequencies if they fall within its range of sensitivity and have sufficient amplitude. Our rods and cones, that is, fire or refuse to fire like on-off switches, depending upon the frequency and amplitude of the *medium-less* waves falling upon them. Our brains then assimilate the pattern of on-off firings, enabling us to encounter a visible world without any of our rods or cones having ever been set into vibration by the touch of any vibrating medium.[14]

When we are hearing, however, we do so by *embodying* the vibrations of the waving media that are *touching* us. Our ear drums especially, having been touched by the vibrating air impinging upon them, are waving as it is waving, and then transferring the wave-motion to contiguous structures of our inner ears before it is converted into a form suitable for neural transmission and processing by our brains.

> Hearing, unlike seeing, is therefore a *tactile* sense – a sense of *touch*!

When hearing, the media within and without me that are conjointly propagating a wave are distinguishable, but the wave they are propagating is the same. I have become an extension of the media propagating the wave, a manifestation of it, *prior* to the wave being converted within me into another form suitable for neural transmission for processing by brain.

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[14] Some readers may be unaware that our rods as well as our cones are capable of contributing to our seeing of things as coloured, as confirmed in a series of classic experiments by Edwin Land and his associates conducted within the Research Laboratories of the Polaroid Corporation, Cambridge, Massachusetts, reported in 1969: "Interaction of the Long-Wave Cones and the Rods to Produce Color Sensations", *Journal of the Optical Society of America*, Vol. 59, No. 1, pages 103-107, January 1969.

Put succinctly, when seeing, our retinas transduce the wave-motion falling upon them into another form suitable for further transmission and processing; when hearing, our ears continue to propagate the waves that set them into comparable motion before those waves are converted. When seeing, nothing has passed from the world without to within us, the wave-motion having been converted at the interface; when hearing, the waves have transcended the boundary between them.

Sensing Ourselves

We may now begin to comprehend how and why our *experience* of seeing differs so markedly from that of hearing and our other senses of touching, how and why it depends fundamentally upon them, and how and why so many thinkers, disregarding the latter, have been unable to fathom how we are able, when seeing, to sense the self that is doing so.

During the late seventeenth and early eighteenth centuries, Leibniz, Hume and Berkeley, perplexed by how we perceive the world coherently, went looking for a 'self' that sees it, discovering to their astonishment that we neither see ourselves when seeing, nor see anything else from which a seeing self could be inferred, from which Kant in 1781 drew the obvious conclusion: the 'I' of which we are compelled to think as unifying our seeing of things can only refer to a formal 'unity of apperception', the unperceivable 'limit of the world' to which the younger Wittgenstein was later to refer.[15]

None of the philosophers that I have mentioned, however, described their quest, or the conclusion they drew from it, as having been circumscribed by their 'looking' for a self that 'sees' the world, for they remained unaware that they were presupposing in common, and erroneously, that the world that we perceive must be rooted within the world as we *see* it, and that any 'I' that sees it must, if sensible, be visually perceivable. So biased were they to the epistemological primacy of the visual that it never occurred to them that the self that sees the world might be sensed other than by seeing it, being a self of which we are aware through our senses of touch, hearing the most nuanced of them. They remained oblivious to the possibility, that is, of an unseeable self that we sense to be a part of the world *touching* us, integrating within it the world that we see. They failed in particular to notice that we *hear* the world only as we hear ourselves.

[15] Ludwig Wittgenstein, *Tractatus Logico-Philosophicus*, vis-à-vis translation by David F. Pears and Brian F. McGuinness (London: Routledge & Kegan Paul, 1961 [1921]), the entries under 5.6 and 5.632 in particular. Wittgenstein's work was completed in August 1918, but published only in 1921 in the final volume of Wilhelm Ostwald's *Annalen der Naturphilosophie*.

We, however, a century after Michelson and Morley, ought to know better. For although we both see and hear by registering how wave-like energy from the world impinges upon us, and by converting that wave-like energy into another form suitable for neural processing by our brains, the locus of the conversion differs. We must therefore rewrite the oft-told story of how and when we sense who we are.

When I am seeing, the conversion occurs at the interface between the world and myself, preserving the distinction between them. The wave-like form of the electromagnetic energy falling upon me is extinguished as it is converted by the rods and cones on the surface of my retinas into the kind of sequenced cellular impulses suitable for transmission into my brain and thereafter processing by it, enabling me to encounter the visible world that I see. The transformation occurs at the interface between the world of things distinct from me within which those electromagnetic waves have their being, and the sensory and neural activities within the retinal surface and cellular structures of my eyes within which no wave-like motions are occurring.

Because the conversion required by seeing occurs at the interface between the world and myself, I remain distinct from how the visible world is. I see how the world, unlike me, has become without having to sense how I, unlike it, have become because of it. Having no need to sense how I am becoming by seeing the world, I waste no time sensing the 'self' that is seeing it. I see a world apart from me without seeing the self that is seeing it, and without sensing in any other way the activities within me of which the seeing of it consists.

When I am hearing, however, wave-like motion that originated elsewhere in the world has become a part of me. My ear drums (and often much of my body) are vibrating in concert with the medium impinging upon them, having become the conclusive segment of a contiguous sequence of media propagating the waves *across* the boundary between the world and myself. By waving as the world about me is waving (or nearly so), I have become as the world is, sharing its form, and the conversion of that form – *my form* – into the kind of sequences of cellular impulses suitable for neural transmission into my brain for processing so that I may hear is an indistinguishable measure of how I and the world have become.

Unlike when seeing, therefore, the conversion required for hearing transfigures a wave-like motion *within me* that has already transcended the gap between the world and myself, rather than occurring at the interface between us. Unsurprisingly, therefore, awareness of sounding things within the world about me presupposes awareness of myself, the self that is waving as they are waving. When hearing, I sense myself to have become an integrated part of the world-as-I-am-using-it, rather than, as when seeing, to be registering solely how the world apart from me has become.

Both hearing and seeing require my brain to register waves impinging upon me, but only when hearing does my brain register how I am waving as the world is waving, having become part of the medium propagating the waves. Only by sensing how *I have become* can I hear the world about me.

One would hardly exaggerate, therefore, were one to affirm that, when hearing, I sense myself *dancing* with the world, for, when I am hearing, the world leads and I follow, moving together in a wave-like embrace of identifying intimacy.

Seeing the World that I am Hearing

By seeing, I become aware of things as distinct from me, but never of myself. But now the question that perplexed Leibniz, Hume, Kant and the early Wittgenstein shifts its centre. For the genuine puzzle was rather why, when seeing things, do I sense that they are distinct from *me*, having seen nothing distinguishable from them (having, that is, encountered by seeing no 'self')?

We may now answer that question, I think, in the only way adequate to it. I see things as distinct from myself (that is, from the self that I sense) because, when seeing, I can identify them as located within a world of things touching me. I am aware of the things that I see only as positioned within an uninterrupted awareness of myself in the world that I have acquired by sensing how things that I am using, and may be seeing, are *touching me*. I see things, that is, as extended parts of a world that, by touching me, renders me present within it as a part of it.

When I bring the sense of myself acquired through hearing and the other senses of touch to my seeing of the world, the self that sees the world has already been integrated within it. I encounter objects and events that I see only when they are recognisable as located before me within the integrated world that is touching me, for our senses of touch, hearing among them, are how we identify ourselves as integrated *parts of*, rather that units distinct from, the world.

Kant may well have been right when he claimed that we can have no temporal sense of ourselves or of anything else without registering the presence of objects distinct from us spatially, and I have said nothing here to suggest that seeing is unimportant to registering how we are within the world. Rather, I am suggesting that it might have occurred to those pondering the consequences of the experiment of Michelson and Morley that one cannot sense how one is temporally within the world (that is, how one feels) by measuring oneself against objects that one sees as distinct from oneself. To register things that one sees as distinct from oneself, one must *first* measure how one is temporally by sensing how one has become as other temporal things are, and how we *hear* is almost always the most encompassing and discriminating tool by which we are able to do so.

When Leibniz, Hume, Berkeley, Kant and the early Wittgenstein went *looking* for the 'self' and couldn't find it, they failed because they were entrapped within the pervasive visual bias that western thinking since Plato has imposed upon the unwary. Had they instead gone *listening* for it, they might well have recognised that we can register what we see only by bringing it to the unified tactile and thus auditory perception of ourselves as centring the unified temporal process that constitutes the world of which we are a part.

Conclusion

We *are* as we are *temporally* (that is, we are as we *hear* and otherwise feel ourselves to be). If, then, when encountering things by means of a film, we are to engage with the things that we see, we must place them within the world of things that we *hear* (within the world of things *touching* us that we *feel*).

> No wonder films have always been 'accompanied' by sounds.
> No wonder the 'coming of synchronous sound' revolutionized filmmaking.
> No wonder no art of 'colour music' has ever been established.
> No wonder the subtlest problems of film design are auditory.

For within a cinema, as within the world about us, we *are* in larger part the sounds that we *hear*, and thus, as Bazin remarked a half-century ago, how we are *hearing* within a cinema determines how we measure, and hence may engage with, the things we that we *see* by means of a film occurring in other spaces and times.

But that, of course, is a subject for discussion on another occasion (indeed, a lifetime of them).